UTILIZATION RESEARCH

Fiscal Year 1960

Agricultural Research Service
U. S. Department of Agriculture

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I. UTILIZATION RESEARCH OBJECTIVE AND OPERATION

The objective of the utilization research program of the Agricultural Research Service is to enhance the use-value and competitive position of farm products in such a manner as to provide more income for the farmer from the crops that he grows. Efforts to find new uses and outlets for farm commodities go across the entire horizon of agricultural interests -- foods, feeds, and industrial products. In recent years there has been an increasing emphasis on the development of large-volume industrial uses for agricultural materials. Ways are sought for imparting new chemical and physical characteristics that make good products still better. Also, entirely new products are being created, through chemistry and other sciences, to meet needs not now satisfied by products from other sources. Such new and broadened uses for agricultural crops help the farmer by giving him more returns and less surpluses. These new and better products give the consumer things he needs and contribute to higher living standards for all.

In planning its utilization research program the Agricultural Research Service benefits from the advice and cooperation of many organizations and individuals both within and outside the Department of Agriculture. Among these are the Farm Research, Marketing Research, and Home Economics Research Divisions of the Department, the Department's Agricultural Research Policy Committee, commodity and functional advisory committees, the State Agricultural Experiment Stations, farm and industry associations, the defense agencies, consultants and collaborators, and representatives of industrial and private research organizations. All segments of the utilization research program are systematically reviewed and appraised for the purpose of reorienting current lines of work in the light of recent developments in agriculture and in industry to assure maximum benefits in the shortest time practicable.

The major portion of the Department's utilization research is conducted in four regional laboratories (at Philadelphia, Pennsylvania; Peoria, Illinois; New Orleans, Louisiana; and Albany, California) and ten associated field laboratories (Washington, D. C.; Beltsville, Maryland; Raleigh, North Carolina; Winter Haven and Olustee, Florida; Houma, Louisiana; Weslaco, Texas; Prosser and Puyallup, Washington; and Pasadena, California). Both basic and applied research is conducted in the fields of chemistry, physics, engineering, biological and related sciences. Process and product developments include pilot plant investigations, with many of the studies extended to evaluations in commercial plants.

Cooperative work -- some under contract -- is undertaken with State Experiment Stations, colleges and universities, and various industrial organizations. Ideas are exchanged with all segments of agricultural interests -- producers, manufacturers, storage and distribution groups, and ultimate consumers.

Recently a foreign program of research has been established largely supported by funds generated under the P.L. 480 program. The utilization portion is well underway in Europe and the Near East, and plans are for extending it to other countries including those in South America and the Middle and Far East.

The results and information developed in the USDA utilization research and development program are made available to the public by many ways. In addition to the voluminous correspondence, personal contacts, and various indirect methods of disseminating information, the following statistics illustrate the broad and continuing efforts made in F Y. 1960 to permit the public to take early advantage of the knowledge developed in this program:

497 research papers published

83 patents granted; 125 licenses issued

415 Papers and talks presented at meetings

51 Industry conferences held

152 press releases issued

28 showings of exhibits

67 appearances on radio and television programs

5,000 to 6,000 technical visitors

II. UTILIZATION RESEARCH ACCOMPLISHMENTS

Some of the more important utilization research accomplishments during fiscal year 1960 were:

Corn Sugar Acids Gain Commercial Importance

New outlets for 10 million pounds per year of corn sugar have resulted from utilization research and development carried out by the Department. Chemical and fermentation processes have been successfully commercialized over the past several years for the production of three new corn sugar acids. These new industrial chemicals -- gluconic, 2-ketogluconic, and saccharic acids -- are now in commercial use in bottle washing compounds, pharmaceuticals, veterinary medicine, and for aluminum etching.

Dialdehyde Starch for Wet-Strength Paper

A new process has been developed that permits using dialdehyde starch, a USDA development previously reported, for imparting improved wet strength to all types of paper including towels, toilet, and facial tissue. The process is much more economical than the one announced in last year's report for treating heavier grades of paper such as bag and blue-print papers. The new development thus widens the opportunities for large-volume usage in the paper industry, which currently produces over two million tons annually of wet-strength paper requiring about 26 million pounds of synthetic resins.

Cereal Wafer for Civil Defense Shelters

In cooperation with the Office of Civil and Defense Mobilization, a cereal-based ration has been developed and evaluated for use in civil defense fallout shelters. The ration consists of a wheat wafer (approximately 50% of the diet), assorted sauces and gravies made from dehydrated products, spreads such as peanut butter or jam, beverages, and sweets. These foods are stable, are remarkably low in cost, and can be used in various combinations to give relatively wide variety in menus. The wheat wafer, which is the basis of the diet, is an outgrowth of the Department's research on bulgur, a parboiled wheat product. The wafer's bland flavor and novel texture give it flexible menu uses. In shelter habitability tests conducted by the Naval Radiological Defense Laboratory in cooperation with OCDM, the participants preferred this cereal-based ration over other diets tested for this purpose.

Proper Conditioning of Wheat for Milling

The proper conditioning and tempering of the wheat kernel is important in the ease of milling and the characteristics of the products. Proper conditioning and tempering is essential for separating wheat, by the new techniques of fine grinding and air classification, into fractions having unique properties better suited for many food, feed and industrial uses. However, there is no general agreement in the wheat milling

industry on how and to what moisture level the wheat should be condioned. As a part of the effort to solve this problem, a world literature survey has been made, and the information published in book form and widely distributed to the milling industry. The very favorable comments made by the milling industry indicates that this is considered a major contribution toward determining optimum procedures for conditioning wheat.

Basic Studies Yield New Starch Products

Utilization research leading to commercial products results largely from information obtained from basic research. A study of starch reactions in non-aqueous solvents resulted in two products (diglucosylamine and imino-bis-1-deoxyfructose) that appear to have unique metal chelating or combining properties equivalent to or better than those of existing commercial materials. Such agents find industrial uses for rust removal, cleansing agents, etching of aluminum, electrodeposition of metals, textile finishing, and as polymerization catalysts. Since the market for chelating agents is increasing, this represents a potentially new commercial outlet for starch. One use of particular promise is as non-toxic chelating agents for removing radioactive strontium contaminants from foods.

Microbial Production of Beta-carotene

There is a large and growing market for beta-carotene, the precursor of vitamin A, for use in animal feeds. A fermentation process was developed two years ago by the Department for producing beta-carotene using media composed largely of soybean oil meal and ground corn. Several industrial companies examined the process and concluded that the yields were too marginal for economical operation. During the past year the process was improved to increase the yields over 50 percent, and ways were found to increase the storage stability of the beta-carotene. This has renewed industrial interest in the process, and there is good likelihood that it ultimately will become a commercial operation.

Modified Wheat Gliadin - A New Stabilizer and Foaming Agent

Methods have been developed for producing high purity gliadin derivatives, made from the protein fraction of wheat flour, that are bland in flavor and suitable for use in many food products. Water-soluble derivatives can be prepared which are relatively insensitive to the presence of salts and are especially well adapted to direct use in foamed foods, such as cooked and uncooked fluffy cake icings, dried-meringue type dessert shells, and nougat or divinity-type candies. Another potential use for the new products is as stabilizers in the USDA-invented foam-mat drying of juices, such as pinapple, orange, and tomato for which proteinaceous stabilizers are preferred. Compatability with oils and tolerance to phospholipids increase the potential use of the new derivatives in fat-containing cake icings, salad dressings, and similar products. Costs of producing these new gliadin derivatives are expected to be moderate.

Increasing Enzyme Activity of Malted Wheat

In a basic study on how to increase the enzyme activity of wheat during malting, it was found that gibberellic acid increased the amylase activity about 90 percent and the protease activity about 50 percent compared to untreated controls. In addition, this increase occurred in the first 3 days of the normal 8-day germination period. The increase in activity and decrease in time is encouraging, and is expected to result in increasing outlets for wheat in the production of malt for use in bread making and for industrial applications.

Pellagragenic Factor of Corn

Pellagra, a niacin-deficiency disease, has long been associated with high-corn diets. Although corn contains an adequate amount of total niacin (a vitamin), it was found to be largely in a chemically-bound form which is nutritionally unavailable. In the production of starch from corn by the wet-milling process, commercial gluten feed meal is a co-product and this meal contains most of the niacin, still in an unassimilable form. Research studies have shown that the niacin is bound to the protein and that the niacin can be made nutritionally available by mild alkali treatment. Work is continuing to develop a practical process, based upon these findings, for releasing the bound niacin and thus increase the feeding value and consequently the market value of corn gluten meal.

New Method of Carding Cotton Widely Used by Industry

As reported previously, enthusiastic industry response was given last year to the Southern Regional Research Laboratory Granular Card, developed to improve the efficiency of cotton processing. The new card, representing the only major change made in the carding machine since its invention 200 years ago, effects a significant reduction in manufacturing costs. Twenty-three firms now are licensed to produce the equipment known as the Granular Card; today more than 250 SRRL Granular Cards are installed in over 70 mills. Two mills are currently planning to convert their entire carding operations to the Granular Card.

Quality Improvements Expand Cotton Consumption

A number of research developments of the past few years in cotton processing methods and methods for measuring the quality of cotton are aiding manufacturers in producing higher quality cotton products. Among these developments are: New knowledge of the relationship of fiber fineness to product quality; new draft guides for better spinning of yarn; improved machine settings and processing of new varieties based on pilot plant studies; a servo-mechanism that automates an instrument for

measuring cotton fiber lengths; a Differential Dye Test, now extensively used in preselecting cottons that will dye uniformly. Although it is difficult to measure accurately the number of bales affected by improving the general quality level of cotton products, it is estimated, as a result of these improvements and similar research by others, that the consumption of cotton today is several hundred thousand bales higher than it would have been without these improvements.

Effect of Short Fibers on Cotton Fabric Quality and Processing Performance

Research has shown that increases in the percentage of fibers less than 3/8" in length in cotton raise processing costs and impair the strength, tear resistance and appearance of fabrics. Because of the significance of these findings, future research will be directed to the development of methods and machinery for mitigating these detrimental effects.

New Process for Producing Easy-Care Wool Fabrics

An entirely new method for shrinkproofing wool has been devised and tested on a laboratory scale. Employing the latest techniques of interfacial polymerization, this treatment results in the formation of an invisible polymeric film firmly attached to the surface of the wool fibers. The reaction occurs rapidly, requires no curing, and does not harshen or weaken the fibers. Wool fabrics treated by this new method retain their original luxurious texture and color. The treatment is compatible with recently developed USDA processes for permanent creasing of wool. Wool garments made from fabrics given this new polymeric treatment are not only shrinkproof, but also are "muss" resistant and their appearance is very little affected by repeated laundering or dry cleaning. The next objective is to develop a suitable method for applying this new treatment in commercial applications.

New Process for Extraction of Cottonseed

A new process employing a mixed solvent - consisting of acetone, hexane and water - has been developed which produces cottonseed meals of improved nutritive quality. In this process the original lysine content of the seed is preserved, the total gossypol is reduced to a low level, and the free gossypol is reduced to substantially zero. These characteristics should make the meals more suitable for feeding to swine and poultry, in addition to the conventional use in feeds for ruminant animals. It has been estimated that the potential market for the meals in poultry and swine feed, in the cotton-growing states alone, is about 4.2 million tons annually, nearly double current production.

Industry Adopts Frozen Food Research Developments

Intensive research by the Department on the effect on quality of the processing and temperature history of frozen foods -- particularly fruit, vegetable, poultry, bakery and precooked products -- has yielded information that is being put into practical usage. This research has included determination of the rate at which product quality of frozen foods declines at various temperatures. These findings have emphasized the need for maintaining these products at 0° F. to assure optimum quality. Wide recognition by industry groups has been given these comprehensive investigations. Improved processing, handling, and distribution practices are being rapidly adopted by all segments of the frozen food industry predicated on the Department's research.

Improved Instant Food Powders

Higher quality instant food powders -- easily reconstituted in cold water -- can now be prepared by "foam-mat" drying, a new method invented by Department engineers which is stimulating major interest throughout the food processing industry. The new drying method involves whipping liquid food concentrates into a foam with the assistance of suitable stabilizers when necessary, spreading the foam on a belt or tray, drying in a stream of warm air; and finally compressing and crushing the dried foam into a free-flowing powder. The fine foam structure persists through compression, so that the property of instant reconstitution is combined with the desired quality of high bulk density. Powders of good color and flavor have been made from the juice of tomatoes, apricots, prunes, pineapples, apples, grapes, and oranges; and from coffee, prune whip, chicken broth and macerate, lemonade, and various pureed vegetables. Additional developmental work is underway to provide information needed for commercial application.

Simplified Process Developed for Full-Flavor Fruit Juice Concentrates

A single-stage process has been developed by Department research engineers for the production of full-flavored fruit and berry juices. In this process the steps of essence recovery and water removal from the juices are combined into one operation and the need for expensive vacuum equipment previously required for juice concentration has been eliminated. Elimination of this step cuts capital investment, and saves labor and floor space. Trained taste panels are unable to distinguish between concentrates prepared by the new method and those made by the more expensive method it replaces. The new process should assist in increasing profitable outlets for fruits and berries.

Increasing Efficiency in Eastern Fruit and Vegetable Processing Plants

Technical and economic information has been developed for the disposal of liquid wastes from Eastern fruit and vegetable processing plants. Such information is essential for efficient utilization of these farm commodities. Data on waste disposal methods and efficiencies were developed in field studies involving cooperation with fifteen processors,

trade associations in six Eastern States, and the National Canners Association. The final report, in the form of a manual for the benefit of those who have had little previous experience in effluent disposal, is especially informative for small processors. Information summarized in this manual also serves as a valuable guide for future studies on this major probem of the processing industries.

Stabilized Raisins for Breakfast Cereals

Since serving fruit with breakfast foods is a popular American custom, prepared cereals containing raisins are generally well accepted, although the shelf life of existing products is short. When raisins are packaged with a cereal, such as "raisin bran flakes," the raisins gradually dry out and lose their normal softness, while the cereal absorbs the moisture and becomes less crisp. A process has been developed for coating raisins with an edible film that effectively prevents this transfer of moisture. The process consists of starch-dusting followed by application of a thin film of beeswax and a vegetable oil. Industry surveys have indicated a market exists for one-third the present domestic production of raisins for use in breakfast cereals and bakery products when coated raisins with the required moisture retention properties become available. Adoption of this new moisture control process should assist in greatly expanding these uses for raisins.

Further Improvement in Citrus Products Through Chemistry

A number of complex chemical substances, members of a class of compounds known as flavanone-disaccharides, have been shown to cause bitterness in products made from several varieties of citrus. Although these substances are different, each contains the disaccharide called neohesperidose which causes bitterness when chemically attached to the flavanone. This bitterness can be destroyed by "splitting" of the disaccharide. The present research gives the key to the previous Department finding that a commercial enzyme preparation could debitter certain citrus products. This elucidation of one of the causes of bitterness will make it possible to devise practical methods for eliminating bitterness in some important citrus products.

Prevention of After-Yellowing in Linseed Oil Paints

White paints and enamels containing linseed oil have a tendency to develop a yellow cast when applied in areas which are not exposed to direct sunlight. This has resulted in decreased use of linseed oil-based paints for interior use. Basic research has shown the probable sequence of chemical reactions leading to "after-yellowing" as it is called. This work indicated that by the addition of certain types of chemicals it is possible to interrupt the reaction sequence and prevent after-yellowing. Work is underway to develop commercially feasible means for controlling after-yellowing. Success should promote the expanded use of linseed oil in paints and enamels for interior use.

New Coating Materials from Soybean and Linseed Oils

Processes were developed for converting the fatty acids of soybean and linseed oils into polymerizable compounds. These were in turn reacted with other commercially available monomers to give new resins which offer considerable promise for industrial uses. Depending on the composition, these resins can be air-dried or baked to give tough, flexible, strongly adherent coatings with a high degree of resistance to solvents and chemicals. Possible uses are in can coatings, wire coatings, and architectural finishes. Two major industrial companies are cooperating in the evaluation of these products. This development should result in a new industrial outlet for soybean and linseed oils.

Upgrading Soybean Oil Meal

Nearly 9 million tons of soybean oil meal are used annually in the U. S., and supplies about 60 percent of the total high-protein concentrates for domestic feeds. Basic research has given new information on the distribution of amino acids in various parts of the soybean. These findings will aid in the development of nutritionally better soybean oil meals. Other research has shown how soybean oil meal can be upgraded to produce materials suitable for increasing nutrient level of foods in dietary-deficient foreign countries, and for increased industrial use possibilities. There is considerable interest in breeding soybeans with higher protein contents than current varieties. This raised the question as to whether these improved soybeans could be processed in the normal way. Experimental lots of these high-protein soybeans were processed and found to require no change in processing conditions.

Special Recongnition by American Oil Chemists Society

The Bond Award, given annually for the best paper presented at the national meeting of the American Oil Chemists Society, was won this year by Dr. Howard M. Teeter of the Agricultural Research Service. Dr. Teeter's paper describing research to determine the molecular weight distribution of soybean oil vinyl ether polymers - information useful in development of new protective resin coatings - was judged best of the 117 papers presented. This is the second time this award has been made, and both times it was won by Agricultural Research Service scientists.

Major Cause of Loss of Sugar into Beet Molasses Discovered

Statistical evaluation of the relationship of sugar content and composition of beet molasses shows the presence of chloride to be the greatest single factor causing loss of sugar into the molasses from which it cannot be recovered. A pound of impurities normally carries about 1.7 pounds of sugar into molasses while a pound of chloride carries 4 to 6 pounds of sugar into the molasses. The removal of 20 pounds of chloride, the amount in a ton of average molasses, would permit the recovery of an additional 80 to 120 pounds of sugar (8 to 12% of the sugar normally carried into the molasses). An economic method of chloride removal should result in an increased income of about two million dollars annually to the sugar beet processors and growers.

Beets Held at Low Temperature Yield Less Sugar

The formation of a substance, called raffinose, in sugar beets interferes with sugar crystallization, a critical step in the refining of beet sugar. Accumulation of raffinose in sugar beets held for processing results in sugar losses costing the Nation's sugar beet industry an estimated seven million dollars annually. Research has shown that in beets held at 34°F. the raffinose content had increased 4-fold compared to beets held at 55°-60° F. This explains why poorer yields of sugar are obtained from beets held at factories in the colder Mountain States than from beets processed in warmer climates such as found in California. The importance of the raffinose problem led to studies which showed the manner in which raffinose is formed in sugar beets. This information should lead to development of means for destroying raffinose or for preventing its accumulation.

New Honey Products

The development of new uses for honey will assure profitable returns to beekeepers, and indirectly benefit a large segment of agriculture since bee colonies are essential to the pollination of many crops. Development of new honey uses has been severely handicapped by lack of technical data on composition and behavior characteristics. Research on over 500 samples of domestic honeys has now been completed, and provides information useful to honey processors and manufacturers of various food and pharmaceutical products. The research has further established the usefulness of honey in pharmaceuticals, especially in retarding settling and improving palatability. A simple continuous process for dehydrating honey without the necessity of additives has been developed; the product, in the convenient form of free-flowing flakes, is of interest to commercial bakers and should find new uses as a component of prepared cake mixes.

Paper Size Directly from Pine Gum

A procedure has been developed for the production of rosin paper size directly from partially neutralized pine gum. Since this procedure obviates the handling of rosin as such, a cheaper process for making size should result. Representatives of gum processing plants, resin manufacturers, paper size producers, and paper companies have expressed interest in the new method. Several paper companies have conducted limited evaluation tests on the new size. It is estimated that approximately 150,000 tons of rosin sizes will be used in 1960 in various applications.

Use of Animal Fats in Processed Feeds Continues to Expand

About 600 million pounds of animal fats were used in processed feeds, mostly poultry, during 1959, which stemmed largely from research conducted by the Agricultural Research Service. Cooperative investigations with industry and others, starting in the early 1950's, showed that from a nutritional standpoint practically all grades of animal fats and tallow could be used in feeds. Further cooperative research has developed effective methods for stabilizing these fats as well as other nutrients in these fields. The fats not only have nutritional value, but also minimize dustiness and improve color of the feeds. In less than a decade this new outlet is off-setting the declining market for animal fats in soap-making caused by the inroads of synthetic detergents, the price for animal fats has been stabilized, and continuing expansion is expected for the use of animal fats in mixed feeds.

Pure Milk Proteins Made Available for Scientific Studies

Information concerning the properties and structures of individual milk proteins is of primary importance in understanding the nutritional properties of milk and the quality of manufactured milk products. An intensive systematic program on the isolation of pure milk proteins has resulted in the preparation of the most abundant proteins of milk in a highly pure form. These pure proteins have been made available to investigators in this country and abroad. The studies on pure milk proteins have resulted in a better understanding of the clotting of milk in making cheese, the stability of milk proteins in manufactured milk products, and the protein sources of the rare milk allergies.

Concentrated Sweetened Cream

A new and economical way has been developed for maintaining the original quality of the fat fraction of milk. It provides a method of processing sweet cream so that it can be held in storage for use in food manufacture where butter or cream with sugar are required as raw materials. The product, concentrated sweetened cream, contains 50% fat, 6% milk solids-non-fat, 27% sugar (sucrose) and 17% water, and does not require low temperature storage. The process provides an effective means of retarding oxidative spoilage which often occurs in such competing products as frozen cream. Limited tests indicate that concentrated sweetened cream is an excellent source of fat in ice cream mix, confections, and other fat-and-sugar-containing foods. Several large dairy companies are considering its manufacture.

Improved Method for Milk Flavor Stabilization

Pasteurized milk can be made to retain its original fresh flavor longer by use of a new deodorization system which retards or prevents the development of oxidized flavor, removes undesirable feed flavors, and saves on heat and cooling costs of processing. A heat treatment of 165°F. for 15 seconds followed by rapid cooling in a vacuum is used, whereas a temperature of 175° or higher is commercial practice. The equipment is designed so that a range of temperature, time, and vacuum conditions can be used. The process is ready for commercial use and several milk processors have shown a strong interest in it.

New Sources of Rancidity in Meat Fats Discovered

The principal cause of deterioration in frozen meat is oxidative rancidity wherein volatile chemical substances with an intense flavor are formed in the meat fats. A low content of these compounds, however, is not assurance of the flavor stability of a fat. Previously unrecognized precursors of these volatile chemical substances have now been discovered. Their amounts are not necessarily associated with the apparent degree of oxidation or the amount of volatile compounds. These precursors break down when the fat is stored, when heated, or when used in the prepartion of foods. Their presence may nullify attempts to prevent oxidation, considerably reduce stability, and render a fat unsuitable for various processing applications. This research provides new knowledge necessary to the development of more effective measures for meat preservation.

Advances in Leather Chemistry Win Special Recognition

The American Leather Chemists Association this year has honored two Agricultural Research Service scientists in recognition of their contributions to the advancement in leather chemistry and in practical leather technology. One of these, a biennial award, was given to Lee P. Witnauer for his research on the effect of water on the properties of untanned leather. This award consisted of an honorarium of $1000 and special presentation of a paper at the International Union of Leather Chemists Societies in Munich, Germany. The Alsop Award, given annually by the American Leather Chemists Association was won by Edward M. Filachione for his research in developing two new tanning processes, one of which utilizes dialdehyde starch, a chemically-modified starch recently developed by other ARS scientists.

Poultry Flavor Developments Useful to Industry

Cooperative studies have been conducted by Department scientists to determine if the eating quality of poultry has suffered from losses in flavor and acceptability arising from the development over the past 15 years of more efficient breeds and feeds. It was found that modern breeds and feeds produce poultry meat with just as much flavor as formerly. Further studies with both chickens and turkeys showed that, contrary to popular assumption, flavor is independent of age in the range of 6 weeks to 6 months. These results should encourage efforts by industry and research institutions to further increase growth rate and feed efficiency. This will permit marketing of birds during the early and more efficient period pf production, thus making available low cost, high quality poultry, and leading to expanded utilization of poultry and feed grains.

III. PROGRAM MODIFICATIONS TO MEET CHANGING NEEDS

Changes have been made during the year in the organizational structure of the four Utilization Research and Development Divisions. The Division Directors' offices have been strengthened by appointment of Assistant Directors with specific responsibilities for leadership in program planning, program evaluation, and industrial liaison. The Assistant Directors relieve the Laboratory Chiefs of previous administrative duties, thus allowing the Laboratory Chiefs to devote their entire effort directly to research. Other organizational changes permit more logical separation of basic research from applied research and development so that each can proceed more unintruptedly. By this means, a steady flow of basic information necessary to product and process development is assured, and greater flexibility of research efforts by all groups is provided. Pioneering research is being encouraged and expanded.

The utilization research and development program is continuously evaluated and modified to assure focusing efforts on important problems. In this way it is made responsive to the changing needs of American agriculture, industry, and consumers. Productive leads are pursued to the fullest extent that resources permit. The newly established Process and Product Evaluation Staff is making critical evaluations of proposals that offer promise of placing significant quantities of agricultural commodities in the chemical and paper industries as well as those that promise improvement in utilization of foods, feeds, and fibers. Program modifications are made in order to provide timely and concentrated work on projects of high potential returns and to discontinue or change the direction of projects which the research has shown to be unpromising.

Examples of program modifications in utilization research for FY 1960 are:

Completion of exploratory phases of investigating reactions for chemically modifying wheat and starch permitted concentration of effort on the development of new polymers from wheat starch and noncarbohydrate monomers (from acetylene and fatty acids) for industrial uses.

With the successful completion of studies of wheat kernel structure in relation to milling quality, work was initiated on a study of factors involved in dry corn milling to increase the yield of corn oil and grits.

The development of methods for determining moisture distribution during tempering and conditioning of the wheat kernel made it possible to apply this information to studies on the conditioning and milling performance of various wheats, thus achieving more efficient separation of wheat into fractions having higher value.

Work on the microbial production of rubber from cereal grain products showed that this approach was not promising and the work was terminated in order to intensify research on the development of microbial insecticides produced from grain for control of Japanese beetles.

Since it appeared that *in vitro* fermentative conversion with rumen organisms of forages and roughages did not improve their value for chick and swine feeding, this research was discontinued and the research effort directed to seeking ways to microbially produce insect toxicants, repellents, and attractants for use as insect control agents.

Research has been successfully completed on the frozen preservation of bakery batters and doughs, and the personnel reassigned to investigations of the properties of wheat fractions produced by the newly-developed air classification methods.

Work on the development of equipment for the better cleaning of cottonseed has been completed and a prototype machine based on these findings is now being evaluated in a commercial scale operation. Personnel from this work have been assigned to strengthen chemical engineering research on cotton finishing.

Investigations on the composition of wool grease were terminated as the information developed seems adequate for present purposes, and personnel was shifted to research work on industrial uses of surplus animal fats.

Newly devised gas-chromatographic studies on strawberry flavor constituants have been successfully completed, and research initiated on means of stabilizing flavor in citrus powders produced by the new "foam-mat" drying technique.

Work to develop a practical test for determining quality of soybean oil meal was completed, and the effort diverted to other studies on soybean protein aimed at developing chemically modified products suitable for new food, feed, and industrial uses.

Research on detoxification of tung meal was terminated upon development of processes that satisfactorily removed the toxic constituents, and the personnel reassigned to work on chemical modification of petroselinic acid with the objective of developing needed industrial raw materials.

Research on the biological hydrolysis of processed and synthetic fats was terminated as the approach did not appear promising, and the personnel reassigned to work on development of new type fats and derivatives suitable for food and industrial uses.

As a result of information developed in exploratory studies of methods and conditions for controlled modification of linolenic acid--the highly reactive constituent of many vegetable oils such as soybean oil--work was intensified on improving the stability of soybean oil to promote its use as a liquid cooking oil.

Work on fermentative production of fumaric acid from sugar was completed, and studies initiated on the fermentative production of alpha-ketoglutaric acid, a new organic acid which has promise for industrial use.

Analytical research work on the composition of honey was completed and the investigators assigned to studies on the characterization and properties of the enzymes of honey.

Research on the utilization of milk whey was terminated and personnel reassigned to investigations for improving the stability of liquid milk concentrates.

Research on the technology of cheese manufacture was curtailed and personnel shifted to investigations for developing commercial methods which could be used for the removal of Strontium-90 from milk in times of national emergency.

Studies on the effectiveness of ultraviolet irradiation in eliminating pathogenic Salmonella organisms from egg products have been completed, and has permitted increased emphasis on development of improved egg white products.

In fiscal year 1960, a total of 150 research projects were terminated for the following reasons:

Research objectives attained	62
Research objectives partially attained	28
Research results unpromising	2
Superseded by research of high priority or of more productivity	25
Exploratory research completed to define specific phases of a problem	33
Total Terminated	150

Initiation of research in entirely new areas, as well as new phases in existing areas, are undertaken on the various agricultural commodities to the extent that resources become available. These resources are from two sources: (a) discontinued research, and (b) new funds. No over-all increase in domestic utilization research funds was made in F. Y. 1960; however, Congress did designate $100,000 for development of new sweetpotato products. New utilization research projects, amounting to $2 million largely extending over a 5-year period, also were started in foreign laboratories through funds made available under the P. L. 480 program.

During fiscal year 1960, considerable consolidation of research was effected by concentrating effort on fewer projects and thereby increasing the efficiency of effort in the most important areas. At the start of fiscal year 1960, there were in the domestic programs 329 "in house" and 77 contract research projects for a total of 406 domestic projects. At the end of fiscal year 1960, after considering newly initiated projects and those discontinued, there were 254 "in house" and 70 contract research projects in effect, or a total of 324.

The 99 new projects--70 domestic and 29 P.L. 480 foreign research projects--initiated in fiscal year 1960 were distributed as follows:

COMMODITY	INDUSTRIAL USES	FEED & FOOD USES	TOTAL
Cereal grains and forages	9	7	16
Cotton and wool	26	-	26
Fruits and vegetables	1	12	13
Oilseeds	7	3	10
New and special crops	5	4	9
Poultry, dairy and animal products	14	11	25
TOTAL	62	37	99

IV. CURRENT UTILIZATION RESEARCH PROGRAM (F.Y. 1961)

Utilization research in the Agricultural Research Service is conducted in four Utilization Research and Development Divisions. Facilities consist of four large regional laboratories and ten smaller field laboratories. The number of scientific and technical personnel employed in the four Divisions on July 1, 1960 was 933.

The current program - at the beginning of F.Y. 1961 - consisted of:

254 projects in the USDA utilization laboratories supported by regular appropriations (exclusive of projects under domestic contracts).

70 projects under domestic contracts.

7 projects in USDA utilization laboratories supported by funds transferred from other Federal agencies.

24 projects directly supported by industry (fellowships).

46 projects in foreign countries under Public Law 480.

The principal areas of research are:

Cereal Grains and Forages

Primary emphasis is on wheat and corn; substantial research also is conducted on other small grains such as rice, barley, sorghum, and oats, and on alfalfa and other forages.

New industrial uses through chemical modifications of the different major components of cereals, particularly dialdehyde starches for improved wet-strength paper and tanning of leather, high-amylose starch derivatives for films and paper coatings, and chemically modified wheat flours for paper sizings.

Fermentative conversion of starch to new polysaccharides and similar polymers that have good promise as thickeners and and dispersants for large-volume industrial uses; fermentative methods for producing nutritive feed and food supplements such as beta carotene; and fermentative processes for making toxicants, repellants, and attractants for control of insects.

Exploratory investigations to develop light-weight insulating and structural boards from wheat products.

Basic studies and development of processes for increasing the feeding value and efficiency of grains and forages.

New air-classification methods for fractionating cereal grains as a basis for "tailor-made" food, feed, and industrial products.

New processes to produce cereal foods that emphasize convenience-in-use, better flavor, and greater stability.

Cotton and Wool

Investigations include chemical, physical and mechanical processing research and supporting fundamental studies of fiber properties and their modifications.

Chemical modification of cotton to give desired properties and uses -- wash-wear garments; fabrics having flame, heat, tear, soil, rot and weather resistance; industrial products.

Processes and equipment for mechanical processing of cotton for improved opening, cleaning, carding, spinning, and fabric construction.

Chemical modification of wool to impart dimensional stability, permanent creasing, and other characteristics necessary for minimum-care garments; to improve resistance to acids and alkalies; to minimize carbonizing, heat and light damage.

Studies of the mechanical behavior of wool fibers, yarns, and fabrics as a basis for improved performance and new uses for wool.

Fundamental studies of chemical and physical properties of cotton and wool fibers necessary to the development of new products and new processes.

Fruits, Nuts, and Vegetables

Research aimed to develop fruit, nut and vegetable products that are attractive, economical, nutritive and meet the increasing demand for convenience-in-use, and to develop processes and equipment for manufacture of these products

New processes for concentrating, drying, freezing, dehydrofreezing, and dehydrocanning of fruits and vegetables.

Time-temperature-tolerance studies of frozen fruit and vegetable products as a basis for improvement of processes and products.

New processes for stabilizing shelled nuts against development of rancidity, darkening and other deleterious changes.

Compositional and enzyme studies as requisites to development of new and improved processed fruit, nut, and vegetable products having greater color stability, better flavor, and enhanced textural properties.

Oilseeds

Major consideration given to soybean, cottonseed, and linseed oils, meals, and related products; investigations also include castor, tung, and selected oilseeds resulting from the new crops screening program. Research stresses new and broadened industrial uses, and seeks to improve feed and food uses.

New chemical products derived from vegetable oils for new industrial uses -- polyvinyl ether films as protective coatings; linseed oil emulsion paints; acids, aldehydes and amides of industrial importance from soybean, linseed and cottonseed oils; urethane foams from castor oil; fire retardant coatings from tung oil.

Improved methods for extraction of oilseeds to achieve broadened industrial, food and feed uses.

investigations to remove any toxic and allergenic constituents of castorseed and cottonseed to permit wider usage of these oilseeds in foods, feeds, and industrial products.

Fundamental studies on composition and properties of vegetable oils, as required for developing industrial products of economic utility and food products of higher quality, including oxicative modifications, color and flavor changes, fermentative transformations, selective hydrogenation, and polymerization reactions.

New and Special Crops

Investigations directed to develop compositional data on crops from world-wide sources in an effort to find alternate crops to fill needs not now met by domestic sources; and to develop new and more economic uses for domestic special crops.

Screening of large numbers of plant materials, from both domestic and foreign sources, (a) for alternate crops, with special emphasis on sources of new types of oils for industrial uses that are not competitive with domestic vegetable oils and animal fats; (b) for new protein sources; and (c) for fiber plants suitable for pulp production.

Improved techniques for the processing of sugarcane, sugarbeet, and maple sap, and developing new uses for honey.

Development of new industrial chemicals from naval stores.

Compositional studies of spices and spice oils.

Research on the chemical composition of tobacco and tobacco smoke to assist industry achieve desired quality in tobacco.

Poultry, Dairy and Animal Products

Research directed to discover new industrial outlets for animal fats and hides, and to develop new food products -- of high quality, convenience, and consumer appeal -- from milk, poultry, eggs, and the more economical cuts of meat.

Research on milk products to develop processes for improved flavor, for gelation control, for removal of any radioactive contaminants, for producing a stable, full-flavored, foam-dried whole milk powder, and for new uses for whey.

New ways to utilize animal fats in lubricants, in detergents, and in plastics and other polymeric products.

New tanning and other processes to make leather more useful, especially in the garment field.

Ways to retain and improve flavor, increase stability, and impart tenderness to meat and poultry products.

Development of egg-yolk-containing and egg-white-containing products with acceptable dispersability, functionality, and flavor stability.

V. SPECIAL APPRAISAL OF UTILIZATION RESEARCH

In addition to the appraisal made each year by the Department's Agricultural Research Policy Committee and the twenty-four commodity and functional advisory committees, during FY 1960 the Secretary of Agriculture appointed a representative of the agricultural industry to make a special study of the USDA program of utilization research. The purpose of the appraisal was to suggest ways to improve, where possible, the application of science to the solution of problems related to the use of agricultural commodities. This study included objectives, planning, personnel, facilities, direction and conduct of research, and other activities concerned in the scientific aspects of USDA utilization research.

Dr. Roy C. Newton, retired Vice-President for Research of Swift and Company, spent almost a year in making this appraisal. His report, released by the Secretary, was based on visits to installations and conferences with key personnel throughout the utilization research organization, and on discussions with major farm organizations, representatives of the farm press, several State Experiment Stations, and a large number of recognized industrial scientists whose activities are related to agriculture. In transmitting his report, Dr. Newton stated, "The Department is to be congratulated on the excellence of this program." He offered a number of constructive suggestions which will be helpful in making further improvements of the Department's utilization research program. Two phases which Dr. Newton indicated as needing additional consideration were the training and development of the younger scientists and the handling of foreign patents resulting from utilization research. A planned program was implemented during the year to strengthen efforts in the former and a detailed study of the latter is in progress. A copy of Dr. Newton's report is attached.

VI. INDUSTRY CONTRIBUTIONS TO UTILIZATION RESEARCH

To achieve maximum returns for its efforts, USDA utilization research needs to work with and be supported by industry. Industry assistance is highly beneficial provided such assistance follows the principle that the public interest must be paramount--that the research is done for the benefit of the public through aiding the American farmer realize greater returns from his commodities and through giving the public better and more economical products. This collaboration can provide the mechanism for industry and the public to take full advantage of new USDA knowledge and developments. Although the basic objectives are different--USDA for public benefit and industry for profit-making--there are many benefits to be attained by this joining hands in approaching the solution of common problems.

A comprehensive study was made during the year of industry contributions to USDA utilization research, and the findings discussed with the Agricultural Research Policy Committee. The study pointed out that the principal advantages of contributions by industry were:

Expedites getting research results adopted by industry.
Permits more intensive work and speeding up of research achievement.
Provides services of specialized personnel and/or facilities
Permits coverage of a larger number of problems.

Industry contributions to USDA utilization research in FY 1960 were estimated to be worth nearly $4 million, most of which was in the form of indirect contributions consisting of research and service work. In addition, industry assisted USDA utilization research by supplying primary data and information concerning raw materials, processes, costs and uses--not available from any other sources-- for about 20 percent of the utilization research projects.

Of inestimable value is the research continually stimulated in industry by scientific work done by USDA. This category includes all types of research--basic, applied technology, market studies and others--on foods, feed and industrial products and processes. The following examples are cited: Nearly a million dollars spent by industry in carrying Department-developed dialdehyde starch derivatives through pilot-plant production and evaluating their possible industrial uses; a half-million dollars spent on developmental studies of phosphorus derivatives of fats for use as low temperature plasticizers; over a quarter-million dollars to develop improved refrigerated railway cars and trucks for transport of frozen foods; a quarter-million dollars by the poultry industry on developing commercial chilling methods to improve poultry tenderness; over half-million dollars by the cotton industry to develop commercial applications of wash-wear finishes.

VII. FINANCIAL INFORMATION

The F. Y. 1960 and F. Y. 1961 domestic Utilization Research and Development funds under "Salaries and Expenses, Agricultural Research Service" including allotments from the special fund for additional labor, are as follows:

	1960 (obligations)	1961 (estimated)
Cereal and forage crops	$ 3,134,500	$ 3,725,000
Cotton, wool and other fibers	3,280,949	3,891,000
Fruits and vegetables	2,613,412	2,812,000
Oilseeds	1,942,984	2,140,000
New and special plants	1,552,457	1,644,000
Poultry, dairy and animal products	3,499,340	3,980,000
Total	16,023,642 a/	18,192,000 b/

a/ In fiscal year 1960, Congress earmarked $100,000 for development of a new dehydrated sweetpotato flake product, including pilot plant studies. A portion of a general reduction in research was applied to other utilization research and development in the amount of $99,400.

b/2 Fiscal year 1961 includes (1) estimated additional amounts required to meet pay act costs under P. L. 86-568 ($885,400) and wage board increases ($121,000); (2) increase of $112,900 for employee health benefit costs pursuant to P. L. 86-382; and (3) an increase of $950,000 provided by Congress which has been distributed as follows:

Project	F. Y. 1961 Appropriation Increase
Cereal and forage crops	
Research to increase industrial use of cereal grains	$400,000
Cotton, wool and other fibers:	
Research on cotton to develop new and improved textiles and processes	325,000
Research on wool to develop new types of yarn from coarse wool	50,000
Oilseeds:	
Research to increase the utilization of castor meal	50,000
Poultry, dairy, and animal products:	
Research to expand or find new uses for animal fats	125,000
Total	950,000

In addition to the domestic Utilization Research and Development program, approximately $2 million was obligated in F. Y. 1960 for research projects, largely extending over a five-year period, in foreign laboratories financed by funds generated under the P. L. 480 program.